Docket No.: 00-18

WHAT IS CLAIMED IS:

1. A method of operating an optical device bidirectionally, the optical device arranged from first through third 2 x 2 devices each having a proximal end and a distal end, wherein signals forward propagate from proximal end to distal end, and backward propagate from distal end to proximal end, and wherein the second 2 x 2 device is coupled to a first distal end port of the first 2 x 2 device and the third 2 x 2 device is coupled to a second distal end port of the first 2 x 2 device to form a cascaded arrangement from the three 2 x 2 devices, the method comprising the steps of:

receiving an input WDM signal at a first proximal end port of the first 2 x 2 device;

forward propagating the input WDM signal through the first 2 x 2 device so as to demultiplex the input WDM signal into first and second subsets of optical signals;

receiving a third subset of optical channels at a first distal end port of the second 2 x 2 device;

receiving a second fourth of optical channels at a first distal end port of the third 2 x 2 device; and

backward propagating the first and second subsets of optical signals through the first 2 x 2 device so as to multiplex the first and second subsets of optical signals into an output WDM signal,

wherein the steps of demultiplexing and multiplexing occur simultaneously to thereby perform bidirectional 1 x 2 optical demultiplexing and 2 x 1 optical demultiplexing.

2. The method of claim 1 including the step of outputting the first subset of optical signals from a second distal end port of the second 2 x 2 device.

3. The method of claim including the step of outputting the second subset of optical signals from a second distal end port of the third 2 x 2 device

4. The method of claim 1 including the step of outputting the output WDM signal from a second proximal end port of the first 2 x 2 device.

5. The method of claim 1 wherein the optical device comprises a planar lightguide circuit.

6. The method of claim 1 wherein the optical device comprises a fiber-based device.

7. A method of operating an optical device bidirectionally, the optical device arranged from first through third 2 x 2 devices each having a proximal end and a distal end, where signals forward propagate from proximal end to distal end, and backward propagate from distal end to proximal end, wherein the second 2 x 2 device is coupled to a first distal end port of the first 2 x 2 device and the third 2 x 2 device is coupled to a second distal end port of the first 2 x 2 device to form a cascaded arrangement from the three 2 x 2 devices, the method comprising the steps of:

receiving an input WDM signal at a first proximal end port of the first 2 x 2 device;

receiving a first subset of optical channels at a first distal end port of the second 2 x 2 device;

receiving a second subset of optical channels at a first distal end port of the third 2 x 2 device;

dividing the input WDM signal into third subset and fourth subsets of optical signals while the input WDM signal forward propagates through the first 2 x 2 device; and

combining the third and fourth subsets of optical signals into an output WDM signal while the third and fourth subsets of optical signals backward propagate through the first 2 x 2 device.

8. The method of claim 7 wherein (N-1) optical devices are arranged in a cascaded array and operated to simultaneously divide N optical channels constituting the input WDM signal and combine N optical channels constituting the first and second subsets of optical channels.

9. A method of operating a cascaded array of (N-1) bidirectional 1 x 2 devices, each 1 x 2 device arranged from first through third 2 x 2 devices each having a proximal end and a distal end, where signals forward propagate from proximal end to distal end, and backward propagate from distal end to proximal end, wherein the second 2 x 2 device is coupled to a first distal end port of the first 2 x 2 device and the third 2 x 2

device is coupled to a second distal end port of the first 2 x 2 device to form a cascaded arrangement from the three 2 x 2 devices, the method comprising the steps of:

receiving N discrete optical signals, each optical signal having a discrete wavelength, at N distal end ports of 1 x 2 devices located at a distal end of the cascaded array;

receiving a WDM input signal having N optical channels at a proximal end port of a 1 x 2 device located at the proximal end of the cascaded array;

forward propagating the input WDM signal through the cascaded array of 1 x 2 devices so as to divide the input WDM signal into N subsets of optical signals; and

backward propagating the N discrete optical signals so as to combine the N discrete optical signals into an output WDM signal,

wherein the steps of dividing and combining occur simultaneously to thereby perform bidirectional 1 x N optical dividing and N x 1 optical combining.

10. The method of claim 9 wherein each subset within the N subsets of optical signals comprises a single optical channel having an associated wavelength.

11. The method of claim 10 including the step of outputting each single optical channel of the N subsets of optical signals to respective N distal end ports of 1 x 2 devices located at a distal end of the cascaded array.

12. The method of claim 9 including the step of outputting the output WDM signal from a second proximal end port of the first 1 x 2 device.

13. A bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer arranged from a plurality of 2 x 2 devices each having a proximal end and a distal end, where signals forward propagate from proximal end to distal end, and backward propagate from distal end to proximal end, for simultaneously demultiplexing a first WDM signal into a first set of optical signals and multiplexing a second WDM signal from a second set of optical signals, comprising:

a first 2 x 2 optical device;

a second 2 x 2 optical device;

a third 2 x 2 optical device;

a first bidirectional optical transmission line coupling a first distal end port of the first 2 x 2 device to the second 2 x 2 device; and

a second bidirectional optical transmission line coupling a second distal end port of the first 2 x 2 device to the third 2 x 2 device to thereby arrange a cascaded stage from the second and third 2 x 2 devices;

wherein the first 2 x 2 optical device is arranged to operate so as to simultaneously demultiplex the first WDM optical signal into the first set of optical signals while forward propagating the first WDM signal through the first 2 x 2 device, and multiplex the second set of optical signals into the second WDM optical signal while backward propagating the second set of optical signals in the first 2 x 2 device.

14. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 13 further including an first output port disposed on the distal end of the second 2 x 2 device for outputting a first subset of the first set of optical signals.

15. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 13 further including an output port disposed on the distal end of the third 2 x 2 device for outputting a second subset of the first set of optical signals.

16. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 13 further including an input port disposed on the distal end of the second 2 x 2 device for receiving a first subset of the second set of optical signals.

17. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 13 further including an input port disposed on the distal end of the second 2 x 2 device for receiving a second subset of the second set of optical signals.

18. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 14 wherein the first subset of the first set of optical signals consists of odd channels.

19. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 15 wherein the second subset of the first set of optical signals consists of even channels.

20. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 16 wherein the first subset of the second set of optical signals consists of odd channels.

21. The bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer of claim 17 wherein the second subset of the second set of optical signals consists of even channels.

22. A combined N x 1 optical multiplexer and 1 x N optical demultiplexer, comprising:

(N-1) bidirectional 1 x 2 optical demultiplexer 2 x 1 optical multiplexers arranged in a multi-tiered cascaded arrangement having m tiers where $2^m = N$, and where each bidirectional 1 x 2 optical demultiplexer and 2 x 1 optical multiplexer is arranged from a plurality of 2 x 2 devices each having a proximal end and a distal end, where signals forward propagate from proximal end to distal end, and backward propagate from distal end to proximal end, for simultaneously demultiplexing a first WDM signal into a first set of optical signals and multiplexing a second WDM signal from a second set of optical signals, each bidirectional 1 x 2 comprising

a first 2 x 2 optical device;

a second 2 x 2 optical device;

a third 2 x 2 optical device;

a first bidirectional optical transmission line coupling a first distal end port of the first 2 x 2 device to the second 2 x 2 device; and

a second bidirectional optical transmission line coupling a second distal end port of the first 2 x 2 device to the third 2 x 2 device to thereby arrange a cascaded stage from the second and third 2 x 2 devices;

wherein the multi-tiered cascaded array is operated to forward propagating the input WDM signal through the multi-tiered cascaded array so as to divide the input

WDM signal into N subsets of optical signals and backward propagating the N discrete optical signals so as to combine the N discrete optical signals into an output WDM signal wherein the steps of dividing and combining occur simultaneously to thereby perform bidirectional 1 x N optical demultiplexing and N x 1 optical multiplexing.

23. The combined N x 1 optical multiplexer and 1 x N optical demultiplexer, wherein one or more of the 2 x 2 devices is an interleaver.

24. The combined N x 1 optical multiplexer and 1 x N optical demultiplexer, wherein one or more of the 2 x 2 devices is a coupler.

25. The combined N x 1 optical multiplexer and 1 x N optical demultiplexer, wherein one or more of the 2 x 2 devices is a Mach-Zehnder interferometer.

26. The combined N x 1 optical multiplexer and 1 x N optical demultiplexer, wherein one or more of the 2 x 2 devices is an Fourier filter.

27. The combined N x 1 optical multiplexer and 1 x N optical demultiplexer wherein each 2 x 2 device includes two distal end ports and an optical isolator is disposed at one of the distal end ports of each of the 2 x 2 devices in the m^{th} tier of the multi-tiered cascaded array..

28. A bidirectional 1 x 2 optical demultiplexing and 2 x 1 optical multiplexing arrangement arranged from bidirectional 2 x 2 devices each having a proximal end and a

distal end, where signals forward propagate from proximal end to distal end, and backward propagate from distal end to proximal end, and further each bidirectional 2 x 2 device having two proximal end ports, and two distal end ports, the arrangement comprising:

a first 2 x 2 device where each of the two proximal end ports is configured as a unidirectional port and each of the distal end ports is configured as a bidirectional port;

a second 2 x 2 device where one of the two proximal end ports is configured as a bidirectional port and each of the two distal end ports is configured as unidirectional port;

a third 2 x 2 device where one of the two proximal end ports is configured as a bidirectional port and each of the two distal end ports is configured as unidirectional port;

a first bidirectional transmission line coupling one of the bidirectional distal end ports of the first 2 x 2 device to one of the bidirectional proximal end ports of the second 2 x 2 device; and

a second bidirectional transmission line coupling an other bidirectional distal end port of the first 2 x 2 device to one of the bidirectional proximal end ports of the third 2 x 2 device,

wherein the input WDM signal received at one of the proximal end ports of the first 2 x 2 device forward propagates through the first 2 x 2 device and is demultiplexed into signals on each of the distal end ports of the first 2 x 2 device while constituent signals received at each of the distal end ports of the first 2 x 2 device

backward propagate are simultaneously multiplexed into an output WDM signal output at the other proximal end port of the first 2 x 2 device WDM signal.